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OBSERVATIONS UPON THE DISTRIBUTION OF PLANTS
IN NEW HAMPSHIRE AND VERMONT.¹

BY WILLIAM F. FLINT.

EVERY one who has botanized must have observed that many of the species common in one part of the country are elsewhere replaced by different ones. We are often surprised to learn that our neighboring botanists find species with which we are most familiar to be only local or altogether wanting in their vicinity.

I have been able to learn of but few attempts to find out the manner in which our New England flora is distributed, or to ascertain the causes which have placed our plants as we find them now.

I do not claim to point out many of the latter, but hope that a few facts as to the manner in which some of the plants in the Connecticut Valley, and elsewhere in New Hampshire and Vermont, are found to be distributed, may not prove wholly uninteresting. I shall not attempt to classify them in the same order as we find them arranged in the manuals, but present them, as nearly as possible, as they would be seen to occur by an observer in journeying from the sources of the rivers toward the sea.

The most important, probably, of the causes which limit the range of different genera and species of plants is that of *altitude*, or the height of the land above the sea-level, as this serves to produce the same differences in the temperature over a small extent of country, which change in latitude does over a larger one.

The flora of Northern New England presents two well-marked divisions, depending mainly upon the different temperature caused by this difference in elevation, which have been termed the Alleghanian and the Canadian. The former is represented by forests composed of chestnut, oak, pitch and red pine, and the latter where spruce, fir, arbor vitæ, and beech predominate.

It is not possible to draw a definite line for the meeting of these two floral districts, because differences of soil and the power which plants have of adapting themselves in some degree to climatic changes bring about a meeting ground of varying width between them.

Were one at the sources of the Connecticut, he could not fail to remark the very different appearance of the flora from that of

¹ A paper read before the meeting of the Connecticut Valley Botanical Society, held at Hanover, N. H., June 6, 1876.

Massachusetts. Here, black spruce (*Abies nigra*), white spruce (*A. alba*), and arbor vitæ (*Thuja occidentalis*), take the place of the oaks, hickories, and pitch pines of this river further south. These, together with the beech (*Fagus ferruginea*), sugar-maple (*Acer saccharinum*), the canoe and yellow birch (*Betula papyracea* and *B. lutea*), constitute the greater part of the forest and present a good type of the Canadian wilderness.

Here, also, Labrador tea (*Ledum latifolium*) and the Canada blue-berry are the representatives of the multitude of ericaceous shrubs found further south. The high cranberry tree (*Viburnum Opulus*) may be found throughout the valley, but in this region it finds its proper home, occurring in abundance along the streams. With it is the hoary willow (*Salix candida*), which, as it is common throughout Northern New Hampshire and Vermont, and extends into Maine, may be considered as a strictly Canadian species.

Two or three species of *Glyceria*, blue-joint grass (*Calamagrostis Canadensis*), timothy (*Phleum pratense*), and reedtop (*Agrostis vulgaris*), represent the greater part of the grass family (*Gramineæ*) belonging to this region. The ponds and slow streams are more likely to contain the variety *pumilum* of the yellow water-lily (*Nuphar advena*) than the typical form.

Going southward, we find that the white spruce (*Abies alba*) disappears from the New Hampshire side of the river at North Stratford; but, singularly enough, it is still found along the Vermont side as far as to the mouth of the Passumpsic River.

At Dalton, N. H., near the head of Fifteen Miles Falls, the hoary willow (*Salix candida*) disappears. The purple meadow-rue, which seems to have a truly Canadian habitat, continues common throughout the length of this long rapid, and is last seen at the Nine Islands near the mouth of the Passumpsic.

The Canadian character of the flora predominates nearly to the foot of these falls, or to within six hundred feet of the sea-level. Here are to be found maiden-hair (*Adiantum pedatum*), *Orchis spectabilis*, sweet-fern (*Comptonia asplenifolia*), frost grape (*Vitis cordifolia*), and sheep-laurel (*Kalmia angustifolia*), forming the first group of strictly Alleghanian species.

As these plants are found in other parts of New Hampshire to have this altitude above the sea at their northern limit, the contour line of six hundred feet can be taken for our purpose, as the dividing line between the two districts.

But there is no disappearance of Canadian species until we

reach the mouth of the Lower Ammonoosuc and Wells rivers. There the Labrador tea (*Ledum latifolium*) is altogether wanting, and the arbor vitæ and high cranberry tree become much less numerous.

The forests which cover the high terraces at the mouth of these rivers are composed of pitch and red pines (*Pinus rigida* and *P. resinosa*) and white oaks (*Quercus alba*).

Mountain rice grasses (*Oryzopsis Canadensis* and *O. asperifolia*) first appear in these woods, which would indicate that they as well as the trees are Alleghanian. A few miles south of this, at Haverhill, N. H., hackberry (*Celtis occidentalis*) and bitter hickory (*Carya amara*) are added, and below this point the Alleghanian type of vegetation predominates in the immediate vicinity of the river. Arbor vitæ and the mountain alder (*Alnus viridis*) are the only Canadian species present, and these find their southern limit at the White River Narrows between Hanover and White River Junction.

Azalea nudiflora is the most noticeable addition before reaching North Charlestown, where we abruptly meet with a group of trees common throughout the valley in Massachusetts. These are chestnut (*Castanea vesca*), yellow oak (*Quercus coccinea*, var. *tinctoria*), shell-bark hickory (*Carya alba*), button-wood (*Platanus occidentalis*), and, growing in their shade, the huckleberry (*Gaylussacia resinosa*) and the rattlesnake weed (*Hieracium venosum*).

Bellows Falls, Vt., seems to be the next place for the appearance of another group, apparently marking the northern limit of dwarf sumac (*Rhus copallina*), shrub oak (*Quercus ilicifolia*), summer grape (*Vitis aestivalis*), liberty tea (*Ceanothus Americanus*), cranesbill (*Geranium maculatum*), *Aster laevis*, *Solidago gigantea*, *Bidens chrysanthemoides*, *Cassia Marilandica*, butterfly weed (*Asclepias tuberosa*), spice bush (*Lindera Benzoin*), fox-tail grass (*Alopecurus pratensis* and *A. geniculatus*), *Calystegia spithamea*, and *Vaccinium vacillans*; quite an array of species which seem to have found these falls an effectual barrier to their march northward.

Along the valley between Bellows Falls and Brattleboro are the high blue-berry (*Vaccinium corymbosum*) and *Andromeda ligustrina*, but it is not quite certain whether or not they should belong with this group.

The cotton-wood (*Populus monilifera*) first appears on an island in the river near the north line of Westmoreland, N. H.,

and is seen very commonly in the immediate vicinity of the river as far south, at least, as the Massachusetts line. Spoon-wood (*Kalmia latifolia*) and gray birch (*Betula alba*, var. *populifolia*) find their northern limit in this town at a point opposite Dummerston, Vt. South of Brattleboro, deer grass (*Rhexia Virginica*), false fox-glove (*Gerardia flava*) and at the mouth of the Ashuelot River in Hinsdale, N. H., *Cornus paniculata* and *Alnus serrulata*, are the principal additions before reaching Massachusetts.

Beside these there are others, and they would probably make up a much larger list, which are probably never found at these northern limits growing at an altitude much above that of six hundred feet above the sea, but for which I have not been able to gather sufficient data to warrant making the same approximation.

I will mention the northern limit at which I have observed a few of them: moon-seed (*Menispermum Canadense*), ground-nut (*Apios tuberosa*), near Windsor, Vt.; *Desmodium Canadense* and *Betula lenta* at South Charlestown, N. H.; *Prunus pumila*, islands of the river near Quechee Falls in Plainfield, N. H.; *Aster undulatus* and water-plantain (*Alisma Plantago*) at Hanover; *Viola sagittata* and river beech (*Carpinus Americana*) at Haverhill, N. H. *Calystegia sepium* and Virginia creeper (*Ampelopsis quinquefolia*) occur as far north as Lancaster, N. H., but are probably Alleghanian species which have been hardy enough to extend thus far northwards in spite of the increased severity of the climate.

The coltsfoot (*Tussilago Farfara*), if an introduced plant, must have entered the Connecticut Valley by the way of Canada, and seems to find the soil and climate north of Dalton best adapted for its growth, being abundant on the high clay banks of the river and along the mountain tributaries, but occurring much more rarely below the altitude of six hundred feet.

The distribution of the different species of grapes belonging to this valley is somewhat interesting. *Vitis cordifolia* is the hardiest, extending as far north as the foot of Fifteen Miles Falls. The summer grape (*Vitis æstivalis*) has not established itself north of Bellows Falls. I have been unable to find that the fox-grape (*Vitis Labrusca*) is indigenous anywhere in this valley, north of Massachusetts; but it is common along Miller's River and its tributaries in that State, which would indicate that the northern point for this species is near its mouth.

A few species seem to have found the valley of the Ashuelot River better suited to their growth than the main river valley north of its mouth. We find the flowering dogwood (*Cornus florida*) at Hinsdale; *Sagina procumbens*; *Cyperus filiculmis*, and *C. strigosus*, common along the plains of Keene and Swansey; and in the swamps, *Symplocarpus foetidus*, which attains a greater range than the others, having established itself in the bogs around the base of Monadnock.

In the Merrimack Valley and that part of New Hampshire east of it, Canadian plants are fewer in numbers, both of species and individuals, than in the same latitude of the Connecticut Valley. Also, owing probably to the greater distance from the high lands, and to being much nearer the ocean, we find many Alleghanian species which do not extend in the Connecticut Valley farther north than Central Massachusetts.

It is somewhat surprising to any one familiar with that part of New Hampshire occupied by the Connecticut and its tributaries, to find the district belonging to the Merrimack the richest floral region in the State, and this, too, notwithstanding that the soil is not nearly so fertile. But it only proves that the warmer temperature of Eastern New Hampshire is more than enough to compensate for any decrease in the number of species that might be brought about by a less fertile soil.

We here find that the species traced throughout the former region do not seem to arrange themselves in groups with wide intervals between them, nor do their limits always appear in the same order.

In the Pemigewasset valley the frost grape first appears near the mouth of the East Branch, but nothing is seen of sheep laurel (*Kalmia angustifolia*) and sweet-fern (*Comptonia asplenifolia*) until near Plymouth, twenty miles further south. *Arbor vitæ* (*Thuja occidentalis*) stops near the south line of Thornton, but its companion, *Alnus viridis*, continues somewhat common to where the junction of the Pemigewasset and Winnepesaukee rivers forms the Merrimack.

A short distance south of the mouth of the East Branch, near the south line of Campton, *Pinus rigida*, *P. resinosa*, and gray birch (*Betula alba*, var. *populifolia*), make their appearance, and the white oak (*Quercus alba*) before reaching Plymouth, but the chestnut is wholly wanting north of the mouth of Smith's River, a short distance below Bristol. *Rhus copallina* is abundant at Livermore's Falls, just north of Plymouth. *Vaccinium vacillans*

and *Quercus ilicifolia* have their northern limit at Boscawen, shell-bark hickory and huckleberry at the mouth of Winnepesaukee River, while buttonwood (*Platanus occidentalis*) is found along the banks of the Pemigewasset, nearly to Plymouth. Mountain laurel (*Kalmia latifolia*) extends north to Concord, and *Asclepias tuberosa* to Thornton's Ferry.

From Concord to Nashua, we find near the river the following species, which appear to be wanting in that part of the Connecticut Valley belonging to New Hampshire. Commencing at Concord we find red ash (*Fraxinus pubescens*), *Clethra alnifolia*, *Scirpus sylvatica*, and *S. microcarpa*. The sand hills at Hooksett are sprinkled with bird's-foot violet (*Viola pedata*). The plains opposite Amoskeag Falls support a dwarf oak (*Quercus prinus*, var. *humilis*), which continues to be abundant, forming along with *Quercus ilicifolia* the shrub-oak thickets so common to these sand plains. Here, also, the bear-berry (*Arctostaphylos Uva-ursi*), generally supposed to be a highland species, occurs in greater abundance than elsewhere in the State.

Some of the swamps in this vicinity are filled with *Cupressus thyoides*, the white cedar of all the coast towns of Massachusetts. Another tree common to the borders of these cedar swamps in the same localities, the swamp white oak (*Quercus bicolor*), appears at the mouth of the Souhegan River, and *Salix tristis* is the common willow of the dry plains in this vicinity. Near Nashua we have *Aster patens*, blazing star (*Liatriis scariosa*), sea sand-reed (*Calamagrostis arenaria*), prickly ash (*Zanthoxylum Americanum*), and in the adjoining town of Hudson the climbing fern (*Lygodium palmatum*). *Struthiopteris Germanica*, the ostrich fern, seems to be properly a Canadian species, not occurring south of Concord in this valley.

We find the water-shed between the Merrimack and Connecticut to have a predominant Canadian flora as far south as the latitude of Bellows Falls. Below this point the Alleghanian plants have found the temperature such as to allow them to attain to higher elevations, and to mingle with the northern types, and the strictly Canadian forest is limited to the cold swamps and summits of the highest hills.

From the data which I have been able to collect concerning Vermont, it appears that the greater portion of the State is occupied by the Canadian flora, and that the area occupied by white and black spruce and arbor vitæ is considerably greater than that occupied by the same trees in New Hampshire; the Alleghanian

area, aside from that of the Connecticut Valley, being included in a narrow belt extending the entire length of the State west of the Green Mountains. Throughout its extent white oak, bitter hickory, pitch and red pine, sweet-fern and frost grape are common, mingling at the northern end of Lake Champlain with the Canadian arbor vitæ and white spruce. The chestnut, button-wood and mountain laurel probably do not exist much north of Burlington.

The following species which are to be met with in New York and further westward do not appear to be found east of the Connecticut Valley, and most of them are confined to the immediate vicinity of the river: *Carya amara*, *Celtis occidentalis*, *Populus monilifera*, *Salix longifolia*, and *Salix livida*, var. *occidentalis*; the last one of these having the widest distribution being found throughout the entire valley, but apparently not passing over the water-shed into the Merrimack district. The hairy-leaved white violet (*Viola renifolia*, Gray; n. sp.) is to be met with between the mouth of the Passumpsic and Plainfield, N. H.

The following may be called rare, having but a single locality for each: *Lobelia Kalmii*, ledges at the foot of Fifteen Miles Falls; *Cypripedium pubescens*, at Hanover; *Arabis Drummondii*, on an island in the river just south of White River Junction; and *Astragalus Robbinsii*, rocks at Quechee Falls, Plainfield, N. H.

THE SUESSONIAN FAUNA IN NORTH AMERICA.

BY PROF. E. D. COPE.

IN a paper read before the National Academy of Sciences at the spring session of 1876 in Washington, the writer announced the identification of the Wahsatch Eocene formation of New Mexico with the Suessonian or Lower Eocene of France and England. The beds, which were explored while connected with the United States Geographical and Geological Survey, west of the one hundredth meridian, in charge of Lieut. G. M. Wheeler, in 1874, were found to contain the remains of a fauna, almost identical with that of the European beds in question. This was thought to be an important accession to American geology, as furnishing a basis for an estimation of the relative ages of the formations immediately above and below the Wahsatch horizon. The parallelism of the fauna includes the genera of reptiles, birds,